Dear SURF Readers,

Welcome to the January 2013 Sanford Underground Research Facility (SURF) monthly newsletter. The newsletter is also posted online, and a pdf copy is available. You can read recent and archived newsletters at our new website at www.sanfordlab.org. We are glad to receive your input on news, links to news articles, upcoming workshops, conference notices, scientific updates, information concerning SURF, employment opportunities, and other highlights relevant to underground science.

Important Dates

February 12, 5:30 PM: **UC Berkeley Physics Professor Beate Heinemann will present a public talk on the recent discoveries at CERN at the Historic Homestake Opera House, 313 W. Main Street, Lead, SD**

February 27-March 2: LUX ZEPLIN (LZ) Collaboration Meeting – College Station, TX

March 4-6: EHSOC meeting - Lead, SD

March 5, 2013: DURA meeting and
March 6-8: Cosmic Frontier Meeting - SLAC, Menlo Park, CA

In Memoriam: Al Mann (age 92) -- *A word from Kevin Lesko*

Bernard of Chartres used to say that we are like dwarfs on the shoulders of giants, so that we can see more than they, and things at a greater distance, not by virtue of any sharpness of sight on our part, or any physical distinction, but because we are carried high and raised up by their giant size. (John of Salisbury, 1159, *Metalogicon*)

It is with heartfelt sorrow that I report the passing of Dr. Al Mann. Al was an early and strong supporter of the U.S. Underground Laboratory effort. He served as an advisor and mentor to me as we developed and matured the DUSEL program. Al was never shy in expressing his opinions or suggesting how we could improve our proposal (or telling me how I was messing up!). While it was not always pleasant to hear this from Al, his batting average for being correct with his advice was very high.

Al had a long and productive scientific career. He was a leader in neutrino experiments, primarily making use of Fermilab and Brookhaven accelerator facilities; pioneering the use of underground experiments to measure astronomical neutrinos; which included the observation of supernova neutrinos and the first real-time observation of solar neutrinos in Kamiokande-II; and significant involvement in the Homestake proposals for an underground lab. Al's papers are (or should be) mandatory reading for physics graduate students:

Atmospheric muon-neutrino / electron-neutrino ratio in the multiGeV energy range. Kamiokande Collaboration (Y. Fukuda (Tokyo U., ICRR) et al.). Phys.Lett. **B335** (1994) 237-245.

Observation of B-8 Solar Neutrinos in the Kamiokande-II Detector. KAMIOKANDE-II Collaboration (K.S. Hirata (Tokyo U., ICRR) et al.). Phys.Rev.Lett. **63** (1989) 16.

Observation in the Kamiokande-II Detector of the Neutrino Burst from Supernova SN 1987a. K.S. Hirata, T. Kajita, M. Koshiba, M. Nakahata, Y.Oyama, N. Sato, A. Suzuki, M. Takita, Y. Totsuka. T. Kifune (Tokyo U., ICRR) et al.). Phys.Rev **D38** (1988) 448-458.

And while it is of limited interest to the general physics community, I used Al's study for an underground laboratory in Nevada in my efforts to develop the NSF's DUSEL, a study that was developed twenty years before DUSEL was born:

Preliminary Site Selection and Evaluation for a National Underground Physics Laboratory. R.R. Sharp, Jr., R.G. Warren, P.L. Aamodt, and A.K. Mann. LA-UR-82-556, December 20, 1981.

Al and his blunt advice will be missed. Al, thank you for all you did to help establish the Sanford Lab and create a domestic underground research facility.

Kevin Lesko presents talk at RPM

On January 17, to a "standing room only" assembly of scientific staff at Lawrence Berkeley Lab's Thursday RPM seminar, SURF Head of Operations Kevin Lesko reported on the current state of SURF, particularly on its science program. He remarked that the research recommended by the National Academy of Sciences is in progress at various stages of development. The LUX experiment to detect dark matter has been installed and is operational at the Davis Campus 4850 Level, and its progeny--the LZ (LUX-ZEPLIN)--is in the planning stage. The MAJORANA DEMONSTRATOR (MJD) experiment to search for neutrinoless double-beta decay in Ge is currently being installed, and its 1-tonne planned successor is in the planning stage. The design for the proposed Long-Baseline Neutrino Experiment (LBNE) to study neutrino oscillation phenomena was reconfigured to include a 10 k-ton (fiducial) LAr detector on the surface at SURF, and a new FNAL beamline accepted by DOE with CD-1 approval to proceed with the design. The proposed DIANA experiment complex to study nuclear reactions of astronomical importance is under review. In addition to these highlighted scientific experiments, other activities taking place from the surface to the 5000-foot level underground include several bioscience and geoscience research efforts.

SURF (formerly DUSEL) moved from NSF to DOE responsibility, with LBNL currently providing management and oversight of SURF operations. The SURF facility has been brought to its current operational status which includes: dewatering from 4300 feet to below the 6000-foot level, the Yates shaft promoted to primary access, the Davis Lab outfitting complete, and the Ross Shaft rehabilitation project. The Ross Shaft rehabilitation is currently in progress, after design completion and review.

Lesko, who traveled over 130,000 miles last year, often presenting SURF in talks such as this, recently presented at the December ASPERA (European network of national government agencies responsible for coordinating and funding national research efforts in Astroparticle Physics) meeting in Durham, England. Derek Elsworth, Penn State, presented the Bio/geo/engineering efforts at SURF (and DUSEL) work connected to these fields to ASPERA, who are also interested in promoting multidisciplinary research at the European underground research labs.

https://indico.cern.ch/conferenceTimeTable.py?confId=199223#all.

Sanford Lab Experiment Timeline

Sanford Lab Director Mike Headley and Head of Operations Kevin Lesko prepared a chart to indicate the long-term potential for experiments at Sanford Lab that Headley showed in a presentation to a recent meeting of the SDSTA Board of Governors. The remarkable transition from mine to deep underground laboratory has already taken place (see Figures 1 and 2). On May 13, 2009, the water level reached 4850 feet, which enabled lab construction to begin. Three years later, a May 30, 2012 dedication ceremony marked the official opening of the Sanford Underground Research Facility (SURF).

Figure 1: Left: Drift on 4850 Level in May 2009; Right: Empty Davis Cavern on the 4850 Level in September 2009

The two main experiments at the current time are the Large Underground Xenon (LUX) dark matter detector and the MAJORANA DEMONSTRATOR neutrinoless double-beta decay detector. LUX researchers have already been adding xenon gas to the detector underground in preliminary testing, and MAJORANA scientists have built the first strings of natural germanium detectors (see Update on page 3). LUX is projected to run through 2016. MAJORANA will operate into 2019.

Figure 2: May 2012 photo of the Transition area - Entrance to the MAJORANA DEMONSTRATOR machine shop on the left

The reconfigured Long-Baseline Neutrino Experiment (LBNE) is still in the proposal stage but in mid-December received Critical Decision (CD-1) approval from the Department of Energy to proceed with design. The projected dates for LBNE covers the years 2012-2040.

Other projects include the Low Background Counting Facility (2013-2040), 1-Tonne Double-Beta Decay (2015-2031), a Generation 3 Dark Matter (2015-2022), and DIANA (2013-2029), although it is considering its site preference. DUGL (Deep Underground Gravity Laboratory) is not listed, but the group has been researching Sanford Lab as a potential site for several years. Biology and geology groups also are active at Sanford Lab; the SURF newsletter plans to present some of their research soon.

The State of South Dakota is fully behind the Sanford Lab projects. South Dakota Governor Dennis Daugaard has included $2 million in his 2013 budget for continuing the replacement of steel in Sanford Lab's Ross Shaft. This improvement will help make longer-term experiments more viable.

The timeline extends to 2040. These dates include all phases of the experiments from R&D, Design, and Construction to Experiment Installation and Operations. To view the graphic online, please go to: http://www.sanfordlab.org/news

SURF Newsletter Supplement Articles

The second in the series of SURF Newsletter Supplement articles, "The MAJORANA DEMONSTRATOR Project at the 4850 Level Davis Campus" is available at:
http://www.sanfordlab.org/lbnl/1198

New SURF website

The new SURF website was launched on November 15. http://www.sanfordlab.org/

Like SURF on Facebook:
http://www.facebook.com/SURFatHomestake

SURF IN THE NEWS

BBC news: *A science news preview of 2013* (Jason Palmer, December 29)
Nature.com: *New year, new science* (Richard Van Noorden, January 1)

Science News: *Heart of the Matter* (Charles Petit, January 10)
Light in the Dark (Tom Siegfried, December 27)

PopSci: 2013 *Prediction: Physics Enters a New Era* (Sean Carroll, January 1)

LBNL news: *Assembling the First Detector Units of the MAJORANA DEMONSTRATOR* (Paul Preuss, December 20)

Phys.org: *Are we closing in on dark matter?* (December 18)

Cleveland Plain Dealer: *Cleveland physicists lead search for dark matter* (John Mangels, December 30)

Slashdot.org: *Tour of the Deep Underground Science and Engineering Lab*

Rapid City Journal: *Editorial: 2013, a better year ahead* (Editorial Board, January 1)
Sanford Lab still growing (Editorial, December 30)
Regents give go ahead on physics PhD (Lynn Taylor Rick, December 13)

Black Hills Pioneer (with Wendy Pitlick): *MAJORANA scientists build first detector* (January 7)
The life of a scientist (January 7)
Scientists make plans for new experiment (January 2)
Sanford Lab attracting national attention: World-class science ramping up, plans for future underway (December 27)
Education and Outreach thriving at Sanford Lab (December 24)
Physics doctoral program, Sanford Lab connected for success (December 19)
Science investments pay off for state (December 15)
New geology model helps scientists at Sanford Lab (December 11)

For *twitter* updates see: www.sanfordlab.org

Reports Available

Prepublication version of the report of the decadal study by the Committee on the Assessment and Outlook for Nuclear Physics (NP2010 Committee): http://sites.nationalacademies.org/BPA/BPA_069589

The National Research Council report – "An Assessment of the Deep Underground Science and Engineering Laboratory": http://www.nap.edu/catalog.php?record_id=13204

Marx-Reichanadter Committee report to DOE: http://science.energy.gov/~/media/np/pdf/Review_of_Underground_Science_Report_Final.pdf
LBNE Reconfiguration Report: http://www.fnal.gov/directorate/lbne_reconfiguration

Paper: *The Large Underground Xenon (LUX) Experiment* will be published in *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment,* Vol. 704, 11 March 2013, pp. 111–126. Available soon!

DURA Election and meeting

The Underground Research Association Executive Committee (DUREC) is calling for nominations and will hold an election before the next annual meeting of DURA. The DURA meeting will be held on March 5, 2013 at SLAC in Palo Alto, prior to the *Cosmic Frontier Meeting and Workshop* of March 6-8. Please contact chair Richard Gaitskell (Richard_Gaitskell@brown.edu) to recommend DURA members who may be interested in serving on DUREC. Currently, DUREC has seven members from Physics experiments, and two members from Bio-Geo-Engineering (BGE) backgrounds. The terms for DUREC are normally for three years. For further information on DURA, see: http://sanfordlab.org/dura

SANFORD UNDERGROUND LABORATORY NEWS

MAJORANA DEMONSTRATOR (MJD) Update

By the end of December, more than half of the ultra-pure copper needed for the MJD experiment had been electroformed. In the summer of 2011, MAJORANA scientists began electroforming copper on the 4850 Level in the MJD cleanroom machine shop (shown in Figure 3). The amount is enough to build the first of two cryostats that will hold detectors made of high purity Germanium enriched in the ^{76}Ge isotope. The process must take place underground in order to protect it from cosmic radiation.

Figure 3: MAJORANA assembly room at the Davis Campus 4850 Level

Strings of germanium detectors are assembled in the cleanroom (shown in Figure 4) inside nitrogen-filled gloveboxes. Germanium detector units are being assembled and tested in seven special aluminum string-test cryostats. To work properly, germanium detectors must be cooled to minus 321 degrees F.

Figure 4: Researchers Wenqin Lu (LANL) and Florian Fraenkle and Matthew Green (Univ. of North Carolina) work on a string of germanium detectors in a glovebox

MAJORANA project engineer Matthew Busch of Duke University designed the machine shop and the ultra-pure copper parts being produced. The MAJORANA researchers bring pure copper nuggets to the 4850 Level underground cleanroom. The copper is dissolved in an acid bath before it is electroformed onto cylindrical stainless steel molds called mandrels.

The copper-coated mandrels are then transported from the electroforming lab to the MAJORANA machine shop. Machinists Randy Hughes (shown in Figure 5) and Russ Bauman of contractor *Adams-ISC* use a lathe to remove the rough copper surfaces.

Figure 5: Machinist Randy Hughes maneuvers a cart carrying a 200-pound cylinder of copper recently quenched from a stainless steel mandrel (right)

Safety is always observed during this process, and in all aspects of life at Sanford Lab. On January 3, Hughes delivered a safety briefing. Working with Baumann, he then opened the oven door and rolled in a small counterweight crane. Using insulated mitts, Hughes attached a hook to the hot mandrel, and Hughes and Baumann rolled it out of the oven. Next, they rolled a stainless steel tank of deionized water into position underneath the mandrel before they continued producing new plate stock.

Safety at Sanford Lab

The Emergency Response Team (ERT) participated in two safety drills in January. The exercises were site-specific to underground emergencies. The training took place at the Homestake sawmill building on January 9, and another session on January 12 in the basement of the Ross Dry building. ERT Coordinator Woody Hover used a Rosco 1500 fog machine filled with *Froggy's Fog* fire and rescue smoke (shown in Figure 6) to produce a smoky, dark atmosphere.

Figure 6: Engineering Technician Kip Johnson participates in a drill at the Homestake sawmill building

In this simulated hazardous environment, the exercise involved connecting two-wire *Femco* telephones, tying knots, writing labels, connecting pipes, and transferring fluids between containers while wearing bulky equipment. The group treated a mannequin's "lacerated leg" and also set up a rescue and retrieval tripod that can provide a lifeline to extract injured personnel from confined spaces. The Sanford Lab ERT consists of about 30 members, which includes Sanford Lab staff and personnel as well as people from local emergency response organizations.

Figure 7: Herb Toor, Tim Roberts and Dan Best - three industrial hygienists from LBNL assess noise and air quality hazards at Sanford Lab during the week of January 14, working with Sanford Lab EHS Manager Chuck Lichtenwalner

EDUCATION AND OUTREACH

Next Generation Science Standards

The second draft of the *Next Generation Science Standards* was opened for public feedback on January 8, 2013, and will remain open until January 29, 2013. Once finalized, the *Next Generation Science Standards (NGSS)* will guide education and outreach programs at Sanford Lab. All interested parties are encouraged to review the draft as individuals or groups at: http://www.nextgenscience.org/next-generation-science-standards.

The latest draft incorporates earlier feedback. The final version of the NGSS is expected to be released in March 2013.

The standards are coded by disciplinary core ideas based on the National Research Council's Framework for Science Education. Each core idea has a progression across grade levels from kindergarten through high school. For the physical sciences, for example, the core ideas are:

1.A. Structure of Matter
1.B. Chemical Reactions
2.A. Forces and Motion

2.B. Types of Interactions
2.C. Stability and Instability in Physical Systems
3.A. Definitions of Energy
3.B. Conservation of Energy and Energy Transfer
3.C. Relationship between Energy and Forces
3.D. Energy in Chemical Processes and Everyday Life
4.A. Wave Properties
4.B. Electromagnetic Radiation
4.C. Information Technologies and Instrumentation

Each standard incorporates each of the three dimensions of the Framework: science and engineering practices, disciplinary core idea, and crosscutting concepts. South Dakota has been a lead state in reviewing the NGSS, and the Sanford Lab Education Department has been an integral member of the team. Expectations are that the standards may be adopted by South Dakota as early as 2014. Work is already in progress on training teachers in the science and engineering practices in advance of adopting the NGSS.

Where does the science pursued at the Sanford Underground Research Facility fit into the new science standards? Examining the twelve physical science ideas above, one can easily come up with examples from Sanford Lab for any one of them. As school districts and teachers change their course curricula to incorporate the NGSS, the Education Department has been and will continue to look for opportunities to incorporate Sanford Lab science in all disciplines and grade levels.

Here are two recent examples:

In the summer of 2012, the Yates Education Building was the site for a teacher professional development workshop, *Physics of Atomic Nuclei in the 21st Century Classroom*. The workshop focused on online resources for teaching modern nuclear and particle physics, and teachers in attendance ranged from fifth grade up through high school physics. Two projects developed from that workshop are:

Lynn Arnold, a fifth grade teacher from Rapid City, SD, has been utilizing a website called *Scales of the Universe* which was developed by two teenage boys in California. Lynn gave a talk at the recent American Association of Physics Teachers meeting in New Orleans about the successful lesson she developed based on the website and other resources. (For more details on the website, see http://abcnews.go.com/Technology/page/scale-universe-cary-michael-huang-california-high-school-15573968.)

John McEnelly, who teaches high school chemistry and physics in Chamberlain, South Dakota, is collaborating with Peggy Norris to develop a nine-week unit on nuclear and particle physics. The module will be tested in Spring 2013 in two of John's physics sections. Through a mini-grant with the American Physical Society, the school has purchased classroom equipment to support this unit. During his involvement with reviewing the NGSS, John came to the conclusion that he needs to add modern physics as a complement to the Newtonian physics he has taught in the past in order to fully prepare and inspire high school students.

ENVIRONMENT, HEALTH & SAFETY

Winter Safety

- Avoid walking on ice. Keep your steps and walkways free of ice as much as possible by using rock salt, chemical de-icing compound, or sand.
- Be careful when traveling on ice-covered roads, overpasses, and bridges. If you are stranded, it is safest to stay in your car. If you must travel by car, use tire chains and take a mobile phone with you.
- Keep your pets inside if possible, especially cats. In spite of a fur coat, your pet's toes, nose, paws, and ears are vulnerable to the cold.

If you are visiting South Dakota, contact (605) 722-0002 for road closure and weather information.

STAFF NEWS

Laurie Gehner, Business Services Department Manager, will be leaving SURF as of January 18. Laurie was one of the original four

staff members who opened the SDSTA Office in Lead in 2006. She played a critical role in establishing the SDSTA's operations and has been a strong advocate within the community for the Sanford Lab. She has done amazing work helping the SDSTA navigate the complexities of federal contracting and meeting the requirements of the Property Donation Agreement that SDSTA has with *Barrick Gold Corp*. Laurie has always been a very professional leader, a caring supervisor, and a great friend. We will miss Laurie and certainly wish her all the best in her future plans. Please join us in thanking Laurie for her dedicated service to the SDSTA.

Jim Hopmeier joined the Sanford Lab staff this month as the Senior Safety Specialist. He brings a unique experience to the Environment, Health, and Safety Department. Previously, he was the safety officer, environmental manager, and quality control manager for an airport realignment project in the Aleutian Islands in Alaska. In the event of an emergency, the U.S. Coast Guard was the first responder. In good weather, a helicopter could make the trip, with a refueling stop, in about 6½ hours. "Logistics was the biggest challenge," Hopmeier says.

The biggest personal challenge was his schedule: seven months on, five months off. "It's not conducive to a family life," Hopmeier says. His wife, Joann, and their three daughters will soon move from Florida to the Black Hills of South Dakota, where they hope to enjoy a more routine family life.

Still, the Sanford Lab presents challenges. The biggest one, Hopmeier says, will be learning the complicated mix of hazards associated with doing world-leading research deep underground. Fortunately, he's comfortable with new challenges. His background includes a master's degree in occupational health and safety, and his experience in construction and occupational safety ranges from building harbors and runways in Alaska to surface mining and real estate development in the lower 48 states.

Hopmeier's favorite quote is from John A. Shedd: *"A ship in harbor is safe, but that is not what ships are built for."*

UPCOMING CONFERENCES AND WORKSHOPS

New Directions in Neutrino Physics, Aspen Center for Physics, Aspen Colorado. February 3-9, 2013. The emphasis of the conference will be on how new experimental techniques and theoretical ideas will impact the future directions of the field. http://aspenphys.org/physicists/winter/currentconferences.html

DURA meeting, SLAC, Menlo Park, CA. March 5, 2013 before the Cosmic Frontier Workshop.

Cosmic Frontier Workshop 2013, SLAC, Menlo Park, CA. March 6-8, 2013.
http://www-conf.slac.stanford.edu/cosmic-frontier/2013/

Workshop in Low Radioactivity Techniques, Laboratori Nazionali del Gran Sasso (LNGS), Italy. April 10-12, 2013. The workshop will examine topics in low radioactivity materials and techniques. This conference is intended to be wide in scope to include all aspects of the development of low background detectors and techniques.
http://lrt2013.lngs.infn.it

SINOROCK Third Symposium, Tongi University, Shanghai, China. June 13-16, 2013. A URL workshop will be held on June 12.
http://www.sinorock2013.org

ARMA, 47th US Rock Mechanics/Geomechanics Symposium, Westin San Francisco Market Street, San Francisco, CA. June 23-26, 2013.
http://armasymposium.org/

Community Summer Study 2013 (SNOWMASS on the Mississippi. Minneapolis, MN, July 29-August 6, 2013. Sessions on five particle physics frontiers: cosmic energy, facilities, instrumentation, and intensity.
http://www.snowmass2013.org

EUROCK 2013, ISRM International Symposium, Congress Centre, Wroclaw University of Technology, Wroclaw, Poland. September 21-26, 2013. Rock Mechanics for resources, energy, and environment.

http://www.eurock2013.pwr.wroc.pl/index.php?id=0

Underground Science Experiments & Research Seminars (USERS) continue bi-weekly on Thursdays, 1:30-2:30 PM. Alternate sessions will be held at LBNL and UC Berkeley, 325 Old LeConte Hall. If you are interested in attending these seminars please subscribe to this email list for future announcements:
http://dusel.org/mailman/listinfo/ugsseminars

DURA Events: Please send information regarding upcoming meetings of interest to DURA members to Richard_Gaitskell@brown.edu or jswang@lbl.gov.

JOBS

Tenure track faculty position in Experimental Particle Physics, UC Davis. Research on LUX and Double Chooz experiments, building a small reactor neutrino detector in Canada, and campaign to measure backgrounds for future underground dark matter and neutrino experiments. Experimental Particle Physics Search Committee Chair, Dept. of Physics, Univ. of California, Davis, CA 95616. dmnu@physics.ucdavis.edu. Deadline: 2/15/13.
https://recruit.ucdavis.edu/apply/JPF00050

Tenure track faculty position at University of South Dakota. Prefer background in theoretical/ computational physics and research interests including dark matter searches, neutrino experiments, or materials science focused on detectors utilized in an underground environment. Review begins 2/1/13.
https://yourfuture.sdbor.edu

Tenure track faculty positions in Physics at South Dakota School of Mines. New SURF-related research program in particle physics, neutrino physics, dark matter, proton decay, and related research that requires deep underground shielding and low-background counting; also seeking a specialist in computational physics. Job #: 0004996. Deadline: 1/7/13.
http://www.sdsmt.edu/employment

Professor and Assistant Professor positions, Physics Dept., Temple University. The tenure-track positions are open to theoreticians and experimentalists in all fields of Physics. Deadline: 1/31/13.
http://phys.cst.temple.edu/professor
http://phys.cst.temple.edu/assis-professor

Research Assistant/Associate in High Energy Physics, Imperial College, London. Work on laboratory R&D and design development for the next-generation LUX-ZEPLIN (LZ) dark matter experiment. Job ref: NS2013003NT. Dr H. Araujo, H. Araujo@imperial.ac.uk.

Postdoc Position, T2K Experimental High Energy Physics, York University, Toronto. Work on the T2K neutrino oscillation experiment. Prof. Sampa Bhadra, bhadra@yorku.ca, Dept. of Physics & Astronomy, York University, 4700 Keele St., Toronto, ON M3J 1P3, Canada.
http://inspirehep.net/record/1203399

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Contributors: Kevin Lesko; Bill Harlan (Sanford Lab local news); Peggy Norris, Ben Sayler (Education and Outreach)

Photo Credits: Fig. 1: Bill Harlan; Fig. 2: Roy Kaltschmidt (LBNL); Figs. 3-7: Matt Kapust.
Photo of Al Mann by Don Polovich of *Rapid City Journal* at an April 2003 demonstration to support turning the Homestake Mine into a research laboratory. (Taken in Lead, SD)

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